Preventive Veterinary Medicine 147 (2017) 142–148

Contents lists available at ScienceDirect

Preventive Veterinary Medicine

journal homepage: www.elsevier.com/locate/prevetmed

Farmers' knowledge and expectations of antimicrobial use and resistance are strongly related to usage in Dutch livestock sectors

Tineke Kramer[a,b,*], Leonie E. Jansen[b], Len J.A. Lipman[a], Lidwien A.M. Smit[a], Dick J.J. Heederik[a], Alejandro Dorado-García[a]

[a] Institute for Risk Assessment Sciences (IRAS), Yalelaan 2, 3584 CM Utrecht, The Netherlands
[b] Public Health Service Region Utrecht, De Dreef 5, 3704 HA Zeist, The Netherlands

ARTICLE INFO

Keywords:
Antimicrobial usage
Farmers
Livestock
Knowledge
Risk perception
Attitude

ABSTRACT

Comprehensive strategies to improve on-farm antimicrobial use (AMU) are needed to contain antimicrobial resistance (AMR). Little is known about farmers' motivating and enabling factors, and about their influence on AMU. In a cross-sectional online survey, Dutch dairy, veal and pig farmers (n = 457) reported their on-farm AMU as "Defined Daily Dose Animal" per year ($DDDA_F$) and completed a detailed questionnaire on their view, knowledge and behavior towards AMU and AMR. Exploratory factor analysis (EFA) on the questionnaire items identified four psychological factors labeled as 'referent beliefs', 'perceived risk', 'knowledge', and 'undesired attitude to regulations'. Linear regression was done to explore the relationship between the obtained factors and on-farm AMU across the three animal sectors. Dairy farmers showed the highest factor scores for 'knowledge' and the lowest for 'perceived risk'. 'Knowledge' scores were significantly and inversely related to AMU (P = 0.0004). Borderline significant associations with AMU were found for 'perceived risk' and 'undesired attitude to regulations' (negative and positive relationships respectively). There were no apparent differences for these relationships between the three livestock sectors. Behavioral interventions in farmers such as educational campaigns or increased support by veterinarians could empower farmers with more prudent and rational practices, eventually reducing AMU in food animals.

1. Introduction

The transmission of antimicrobial resistant bacteria from livestock into the environment and food chain is a public health concern. In the last years, potential risks of antimicrobial resistance (AMR) transmission at the animal-human interface have been extensively documented (EMA/EFSA, 2017). Lowering on-farm antimicrobial use (AMU) in livestock production is regarded as the most logical intervention for containing the AMR threat originating from animals. As an example, veterinary AMU has halved since 2010 in the Netherlands, due to stringent regulations (Nethmap/Maran, 2016) and data suggest it has led to noticeable reductions in resistance levels in livestock (Dorado-Garcia et al., 2016). In addition to these regulatory and technical farm interventions (e.g. increased biosecurity), behavioral interventions aimed at sustainable AMU reduction should be considered as part of comprehensive One Health AMR action plans.

Evidence from human medicine relating psychological factors to potential misuse or overuse of antimicrobials is unequivocal. Studies describe that patients' expectations, or perceived expectations by the physician, are strong drivers for prescription of antimicrobials in human medicine (Britten and Ukoumunne, 1997; Cockburn and Pit, 1997; Mangione-Smith et al., 1999; Cho et al., 2004; Welschen et al., 2004). Knowledge, beliefs and previous experiences with antimicrobials of the patients as end-users influence these expectations (Cals et al., 2007). In veterinary medicine, comparable drivers (e.g. (perceived) pressure from farmers as end-users), have been shown to influence the veterinarian to prescribe (Speksnijder et al., 2015; Coyne et al., 2016; McDougall et al., 2017).

Farmers are important actors in modulating their on-farm AMU. Together with the veterinarian, Dutch farmers design and implement the so called "farm treatment plan" (FTP) which contains farm specific protocols for AMU. Additionally, in many countries, farmers have direct influence on AMU through either purchasing or dosing and administrating antimicrobials independently, or under indirect supervision of the veterinarian. These decisions are not fully rational and are in any case partly driven by motivational and enabling factors (Panter-Brick et al., 2006).

In dairy farmers, but mostly in pig farmers, some aspects of

* Corresponding author at: Institute for Risk Assessment Sciences, Department Veterinary Public Health, Yalelaan 2, 3584 CM Utrecht, The Netherlands.
E-mail address: T.kramer@uu.nl (T. Kramer).

http://dx.doi.org/10.1016/j.prevetmed.2017.08.023
Received 28 June 2017; Received in revised form 30 August 2017; Accepted 30 August 2017
0167-5877/

psychological factors towards AMU and AMR have been described (Friedman et al., 2007; Moreno, 2014; Jones et al., 2015; Visschers et al., 2015; Dupont et al., 2017). However, their impact on AMU across multiple livestock sectors has not been quantified before. These studies identified knowledge gaps among farmers on how to use antimicrobials, concluded that farmers may benefit from further education on AMU, and stressed the important role of the veterinarian and possibly also farmer specific guidelines for AMU.

Therefore, the aims of this study were to characterize farmers' motivating and enabling factors towards AMU and AMR in three major animal production sectors (dairy cattle, veal calves and pigs) and to explore the impact of these psychological factors on their on-farm AMU.

2. Material and methods

2.1. Selection of farmers

Farmers (N = 4041) were selected from the membership database of the Dutch Federation of Agriculture and Horticulture (LTO) based on farm size (>100 calves, >200 sows, >800 fattening pigs, >100 dairy cattle or >40,000 broilers). They were randomly selected across all three regional LTO offices in the country. Fig. 1 shows the process for selecting the study population and data cleaning steps. Since not all LTO offices kept track of how many farmers per sector they invited to participate, the response rates per sector could not be defined.

2.2. Online questionnaire and data collection

Questions were included following discussions with experts and analysis of questionnaires of previous studies focusing on the general public or human patients (Cals et al., 2007; Grigoryan et al., 2007; McNulty et al., 2007; Radosevic et al., 2009; Andre et al., 2010; Chan et al., 2012; Widayati et al., 2012; European commission, 2013; Napolitano et al., 2013; Wun et al., 2013; Hoffmann et al., 2014). The questionnaire consisted of general or human health items and veterinary and farm related questions. The main topics were knowledge, risk perception, attitude and (intended) behavior towards AMU and AMR. Box 1 further explains these main domains of the questionnaire.

The questionnaire concluded with general characteristics of the farm and farmer, leading to a total of 121 items. Responses included dichotomous and categorical outcomes (yes/no; a/b/c) and ordinal

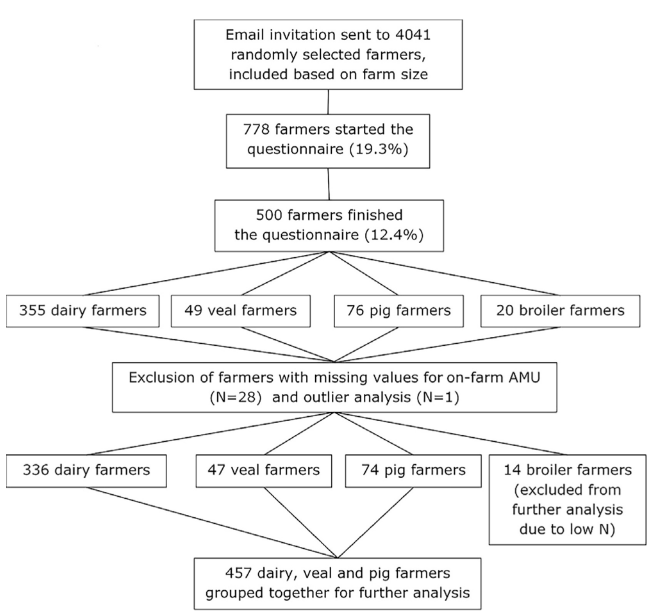

Fig. 1. Flowchart for the selection of the study population and data cleaning steps. Percentages in brackets are the response rates.

outcomes (5-point Likert scale type). A pilot study was performed among a selected panel of farmers (N = 26) to test and improve the comprehensibility of the questions. Medical terms and clinical diagnoses were explained in information boxes to improve the understanding of the items when appropriate. The full questionnaire is provided in the appendix in Supplementary material.

A web-based survey software program (NetQ Healthcare, Utrecht, The Netherlands) was used for the data collection. Farmers received an email invitation to fill out the anonymous internet-based questionnaire between February and March 2015. It was made impossible to skip questions or go back in the questionnaire, to prevent missing values and editing of previous answers. Since items for sector membership and self-reported on-farm AMU were among the last questions, only complete observations (N = 500) were included. Missing values for AMU were screened, which resulted in the exclusion of 28 farmers. One additional farmer had extremely unlikely answers for all knowledge questions and was excluded from the definite analysis (Fig. 1). Sensitivity analysis including this outlier did not change the final model estimates (results not shown).

2.3. Statistical analysis

Statistical analysis was performed using SAS software, Version 9.4 (SAS Institute Inc., Cary, NC, USA). To identify latent psychological constructs from the questionnaire items, exploratory factor analysis (EFA) was done with PROC FACTOR for dairy, veal and pig farmers combined (N = 336, N = 47 and N = 74 respectively). EFA was chosen because of a lack of a priori theory in this field on item structure. Items from the questionnaire (Appendix A in Supplementary material) with ordinal scales and binary outcomes were used. When Spearman correlation between two items was >0.7, only one of them was kept based on perceived importance and previous knowledge. Items with communalities <0.3 after an initial EFA were removed. The factorability of the remaining items was examined with the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy. The factor extraction was done as described elsewhere (Suhr, 2006), starting with initial extraction and determination of the number of factors to retain. Orthogonal (varimax) rotation was performed to improve the factor structure. Cross-loadings of an item with a gap of >0.2 between the primary and secondary factor loading were considered insignificant. A factor was defined by a minimum of 3 items loading >0.4 and a minimum of 5% of variance explained by the factor. Cronbach's alpha's were calculated to test internal consistency of factors' composition. From the final set of 66 items, with a KMO of 0.7, factor scores were calculated. Distribution of factor scores by sector was explored with boxplots. An analysis of variance (ANOVA) and post hoc Tukey tests were used to identify significant differences in mean factor scores overall and between sectors. A selection of *a priori* important items excluded from factor analysis were analyzed descriptively.

AMU was self-reported by the farmer in the form of the most recent "Defined Daily Dose Animal" per year on the farm ($DDDA_F$). The Netherlands Veterinary Medicines Authority (SDa) calculates this value for benchmarking of individual livestock farms. The SDa was founded in 2010 and acts as an independent agency for prudent AMU in Dutch animal sectors. Farmers are informed of their $DDDA_F$ through sectoral quality organizations. The $DDDA_F$ can be interpreted as an approximation of the number of days an animal on a farm receives antimicrobial treatment per year. A more detailed description on the calculation of $DDDA_F$ is described elsewhere (Bos et al., 2013). To deal with the right-skewed distributions and the large differences in $DDDA_F$ range by animal species, $DDDA_F$ values were log-transformed [$\ln(x + 1)$] across all sectors and standardized around a mean of 0 and standard deviation of 1 per sector.

The relationships between the obtained factors, as explanatory variables, and the transformed AMU, as outcome, were explored with a linear regression model for all sectors together using PROC GLM.